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The Role of Attention in the Other-Species Effect in Infancy

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The Role of Attention in the Other-Species Effect in Infancy

A Thesis Presented for the
Master of Arts
Degree
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Dantong Zhang
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Dedication

This is dedicated to my five years from 2007 to 2012 in this free country.

Abstract

Infants experience a gradual decline in the ability to discriminate other-species faces during the first year of life (Pascalis, de Haan, & Nelson, 2006). It is possible that this decline is due to infants distributing more attention to human faces than to other-species faces. The current study explored the effect of modifying the distribution of 9-month-old infants' selective attention during the processing of monkey faces. After familiarization with monkey faces with successively highlighted internal features, infants showed significant preference to novel faces in paired-comparison tasks. In contrast, infants in a control group with no highlighting during familiarization did not show evidence of discrimination. These findings support the possibility that modifying infants' selective attention facilitates recognition of other-species faces, and indicate that perceptual narrowing may work at the level of selective attention.

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Chapter 1

Introduction and General Information

Just a few minutes after birth, human infants can visually track a face-like pattern more effectively than a random pattern (Goren, Sarty & Wu, 1975; Johnson, Dziurawiec, Ellis, & Morton, 1991). Newborns are able to show evidence of recognition memory for certain faces, and by 3 months of age, infants with female primary caregivers have demonstrated the ability to discriminate different female faces (Quinn, Yahr, & Kuhn, 2002). Adults are experts at discriminating faces, and are able to quickly detect minor differences between faces with very brief exposure, but they are more likely to make mistakes when it involves faces from an unfamiliar species. Similarly, adults are better at discriminating faces from their own race than faces from another race, which is referred to as the other-race effect (For a review, see Meissner & Brigham, 2001).

How this particular effect emerges in development has been studied intensively in the past decade. Scott, Pascalis, and Nelson (2007) propose a domain-general principle in which the development in various developmental fields during the first year of life is characterized by a process of perceptual narrowing. Perceptual narrowing refers to cases in which discrimination of perceptual information is broadly tuned at first and then declines to more selective levels which are more relevant to early experience and the surrounding environment. Evidence for perceptual narrowing can be observed in language perception (Kuhl, Stevens, Hayashi, Deguchi, Kiritani, & Iverson., 2006), multimodal perception (Lewkowicz & Ghazanfar, 2009), and musical rhythms (Hannon & Trehub, 2005).

Chapter 2

Literature Review

Perceptual narrowing in development

Perceptual narrowing in language acquisition

Adults are experts discriminating at speech contrasts from their native languages, but are often unable to distinguish speech contrasts present in nonnative languages. It has been observed that there is a developmental decline in the discrimination of speech sounds not present in one's native language. For example, Werker and Tees (1984) tested whether English infants, English adults, and Thompson adults could discriminate a pair of speech contrasts /ki/ and /qi/ only present in the Thompson language, and found that all the Thompson adults and most English infants successfully discriminated the pair of contrasts, whereas the ability of English adults was much more limited. The decline could be observed during the first year of life in the Thompson and the Hindi languages for infants reared in English speaking environments. English infants lost the ability to distinguish Hindi phonemic contrasts /Ta/ and /ta/ at some point between 6 and 12 months of age. Six- to eight-month-old infants could discriminate consonants from other languages that are not present in English. However, older infants at 10-12 months of age did not. In another study (Kuhl et al., 2006), 6-8- and 10-12-month-old infants in the United States and Japan were tested using the English contrast /r/ and /l/. It was found that American infants showed a significant increase in their performance in the discrimination tasks between 6 and 12 months of age, whereas Japanese infants' performance decreased with age, but still remained above chance. Werker and Tees (2005) concluded that with continuous exposure to one's native language, the ability of infants to discriminate native consonant contrasts increases, whereas that ability to discriminate nonnative contrasts declines.

Such changes are based on experience, and it has been found that the narrowing process can be modified with mere exposure to novel languages. For example, 9-10 month-old English infants who were exposed to Mandarin Chinese during play sessions showed better abilities to discriminate Mandarin Chinese phonetic contrasts than a control group (Kuhl, Tsao, & Liu, 2003). However, social interaction was necessary to reverse the decline. It was found that infants who were exposed to audio-visual or audio-only recordings did not show better results in the discrimination test than a control group. In addition, Jansson-Verkasalo and colleagues (2010) found that prematurely born infants exhibited atypical perceptual narrowing and could still discriminate phonemes from nonnative languages at 2 years, which is related to worse performance in communicative language tests. This suggests that the perceptual narrowing process can predict normal native language acquisition.

Perceptual narrowing in music perception

Perceptual narrowing can also be observed in music perception with increased experience with native music. Similar to the other-race/species effect in face perception, North American adults can detect the alterations of simple metrical structure which is dominant in North American music, but cannot detect the change if it is based on complex metrical structure which is dominant in Balkan music (Hannon & Trehub, 2005). However, 6-month-old North American infants are able to detect the changes based on both musical structures, whereas 12-month-old infants perform similar to North American Adults. With these older infants, a 2-week exposure to the complex meters can reverse the narrowing effect in that they become capable of detecting the changes based on complex structure once again.

Perceptual narrowing in the development of multisensory systems

In a review of the role of perceptual narrowing in the development of multisensory systems, Lewkowicz and Ghazanfar (2009) proposed that this regressive process contributes in important ways in multisensory development. Traditionally, it was believed that the basic multisensory perceptual abilities are not present at birth, and with increased experience, such abilities can emerge gradually during the first years of life (Birch & Lefford, 1967; Piaget, 1952). Another theoretical view proposes that multisensory perceptual abilities are present at birth, and experience helps to refine and differentiate them to be more specific and efficient (Gibson, 1984). The perceptual narrowing view is different from the previous views that unlike the progressive processes described above, it states that at birth, perceptual tuning is broad, and allows infants to respond to various attributes. With increased experience, responses of infants are narrowed to native perceptual attributes. Previous research has shown perceptual narrowing in development of various sensory systems, and it is possible that multisensory systems also experience similar developmental trends.

Several studies provide support for multisensory perceptual narrowing. Lewkowicz, Leo, and Simion (2010) demonstrated infants' looking preference to monkeys with matching visible calls. Lewkowicz and Ghazanfar (2006) tested 4-, 6-, 8- and 10-month-old infants to explore whether their sensitivity to multisensory relations narrows across age. Infants were exposed to two movies side-by-side in which the faces of a monkey were producing a coo call on one side and a grunt call on the other side. It was found that 4- and 6-month-old infants were able to match the visual and audible calls. When they heard the audible calls, they tended to look longer at the matched visual stimulus. In contrast, older infants did not exhibit evidence of multisensory matching. When the synchrony of visual and auditory signals were interrupted, young infants showed failure of such matching. Such decline in multisensory matching continues up to 18 months of age (Lewkowicz. Sowinski, & Place, 2008). The authors proposed that younger infants relied on the synchrony across modalities to match up visual and audible stimuli, but for older infants, higher-level, more meaningful social features are more important for information processing, so they lose the ability to integrate vocal and facial information from other species. Similar evidence can be found in language studies.

Pons, Lewkowicz, Soto-Faraco, and Sebastián-Gallés (2009) tested infants aged 6 to 11 months, and their findings suggest perceptual narrowing occurs in multisensory speech. They used a similar procedure in which movies of a woman speaking were displayed side by side, with one of the soundtracks of the two movies presented at the same time. It was found that young infants showed evidence of matching the auditory and visual nonnative phonemes, whereas older infants failed to match auditory and visual phonemes not present in their native languages. Lewkowicz and Ghazanfar (2009) concluded in their review on perceptual narrowing in multisensory perception that infants’ sensitivity to native face-voice relations improves with experience, and at the same time, their ability to detect nonnative face-voice relations declines.

Perceptual narrowing in face recognition

According to Nelson (2001), face recognition also follows a similar developmental trend. At birth the dimensions of the face prototype are broad in that infants can recognize faces from various species and races, and such abilities continue to develop based on experience with age. As the exposure to own-species and own-race faces increases over age, the face-space dimensions are tuned toward that category. It suggests a gradual change in development in that the ability to discriminate individual faces narrows down to one’s own-species according to early experience. This developmental model receives support from recent studies (e.g. Pascalis, de Haan, & Nelson, 2002; Pascalis et al., 2005). Pascalis, de Haan, and Nelson (2002) examined infants’ ability to discriminate faces from other species. The findings supported a perceptual narrowing process in face recognition. Participants were 6- and 9-month-old infants and adults. It was found that six-month-olds could discriminate faces from both human and monkey groups, whereas 9-month-olds’ and adults’ discrimination was restricted to human faces. Using sheep faces and event-related potentials (ERPs), de Haan, Pascalis, and Johnson (2002) found that adults exhibited a significant response only to inverted human faces, and 6-month-old infants responded similarly to human and nonhuman faces. However, in another study (Scott, Shannon, & Nelson, 2006), 9-month-old infants demonstrated different ERP responses to monkey and human faces, suggesting more specific processing of human faces.

Studies involving faces from different ethnic groups are not as many as those on the other-species effect. Some studies suggest that infants as young as 3 months of age have shown the other-race effect in that they prefer to look at faces from own-race groups (Kelly et al., 2005), and they cannot discriminate other-race faces (Hayden et al., 2007), but such effects can be eliminated with minimal exposure to other-race faces (Sangrigoli & de Schonen, 2004). Bar-Haim, Ziv, Lamy, and Hodes (2006) examined infants' looking preference to own-race versus other-race faces based on environmental exposure. Their participants were Caucasian infants living in a Caucasian environment, African infants living in an African environment, and African infants living in a predominantly Caucasian environment, all aged 3 months old. Preference to own-race faces was observed only in infants living in homogeneous own-race environments, but not in infants who experienced intensive exposure to other races.

To clarify the developmental changes of other-race effect during the first year of life, Kelly and colleagues (2007) examined Caucasian infants aged 3, 6, and 9 months. The stimuli they used were color photos of male and female adult faces from four different ethnic groups, African, Asian, Middle Eastern, and Caucasian. Infants were firstly familiarized with a face from one of the four groups, and then entered a paired-comparison phase in which the familiar face was paired with a novel face from the same ethnic group. To exclude the possibility that infants were habituated to the picture rather than the faces, faces used in the two phases had different orientations. The results indicated that 3-month-olds showed novelty preferences in all the four ethnic groups. Six-month-olds only showed novelty preferences when presented with Asian and Caucasian faces, whereas 9-month-olds only showed signs of discrimination of faces from their own race group. To generalize the results to other ethnic groups, Kelly et al. (2009) recruited Chinese infants in another study using the same procedure. It was found that the development of other-race effect was also similar in the Asian group. Kelly and colleagues suggest that the other-race effect may develop through the following processes: First, early exposure to faces from an individual's own group induces a visual preference for own-race faces. Second, such preference then produces greater visual attention to own-race faces. Third, superior cognitive abilities develop specifically for one's own group rather than groups unfamiliar to individual.

The mechanisms responsible for the specialization in face discriminatory abilities are still not clear. One explanation is that infants may process faces from other species at a summary level. In other words, they may engage in categorical perception when processing faces from an unfamiliar category. At the same time, if they encounter faces from their own species, they recognize them at the subordinate or individual level. To test this hypothesis, Pascalis and colleagues (2005) had 6-month-old infants exposed to six monkey faces labeled at the individual level with each monkey assigned a unique name (e.g. Dario, Boris, Flora). In this condition they found that, at 9 months of age, infants successfully maintained their ability to tell individual monkey faces. Further, Scott and Monesson (2009) had 6-month-olds trained for 3 months in their home environment with monkey faces labeled at 3 different levels: the individual level, the category level (monkey), and with no labels. After the training at 9 months of age, infants who were exposed to monkeys with the category label and no label failed to discriminate other-species faces. Only the individual level group maintained the ability to discriminate monkey faces. In another study (Scott and Monesson, 2010), infants received similar training at 3 different levels from 6 months to 9 months of age. After training, infants were presented with upright and inverted monkey faces in ERP trials. Neural specialization was found in the group of infants who were exposed to monkey faces labeled at individual level, in that they exhibited an occipital-temporal ERP inversion effect similar to what can be observed when adults process upright and inverted human faces. However, such effect could not be observed in the groups trained with monkey faces labeled at category level or without labels, suggesting the importance of early experience with individuating faces.

In terms of human faces, Anzures and colleagues (2009) examined whether 6- and 9-month-old Caucasian infants had formed face categories according to race. For 6-month-old infants, there was no significant increase in looking time to Asian faces after familiarization with the category of Caucasian faces, indicating that 6-month-olds did not form a category of Caucasian faces that excluded Asian faces. For 6-month-olds familiarized with Asian category in the other condition, there was a significant increase in looking time to Caucasian faces after the familiarization trial, which might be driven by infants' simultaneous preference to own-race faces. For 9-month-olds in both conditions, it was found that different from the younger group, they looked significantly longer at faces from novel race categories after familiarization with Caucasian and Asian categories, demonstrating that infants at this age had formed categories according to races. Therefore, 9-month-olds have formed a subordinate category of faces from their own race (i.e., Caucasian) which is qualitative different from that of Asian faces. Older infants started to engage in categorization of own-race faces and categorical perception of other-race faces, whereas younger infants had not formed such categories and demonstrated an asymmetry in looking behavior that might be driven by simultaneous preference to own-race faces.

Considering the asymmetry observed in the recognition of faces from own- and other-species, it is important to find out if there is any difference in processing strategies used by older infants showing such perceptual narrowing. There is some support for this possibility from studies on the other-race effect. For example, Blais, Jack, Scheepers, Fiset, and Caldara (2008) reported that Asian adults tended to focus longer at the central area when scanning both own-race and other-race faces, but during recognition and categorization of other-race faces the effect became less pronounced, suggesting that different strategies may be used to process own- and other-race faces. In terms of infants' face processing, young infants with female primary caregivers prefer to look at female faces in preference tests (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002). Similarly, 3-month-old infants have demonstrated a preference to look at faces from their own race (Kelly et al., 2005; Bar-Haim, Ziv, Lamy, & Hodes, 2006).

As suggested above, such preferences in early life may lead to longer processing time of own-race faces and ultimately more efficient information processing, and result in the decline in ability to discriminate unfamiliar faces. Liu, Quinn, Wheeler, Xiao, Ge, and Lee (2011) examined the similarity and difference in the processing of own- and other-race faces in Asian 4- to 9-month-olds using eye-tracking. They found that, with increasing age, the time infants spent looking at the internal features of other-race faces decreased, whereas the time they spent looking at the internal features of own-race faces was maintained. The most significant decrement happened to the time they spent looking at the nose area of the other-race faces. Therefore, worse performance in recognition of other-race faces in older infants may be based on selective attention and shorter looking to the internal features of other-race or other-species faces, may lead to inadequate processing of the internal features which are important for individuation of faces.

Infant selective attention

Attention is limited and only certain information can be processed at any given point in time. Selective attention is fairly important for individuals to pick up specific information from the surrounding world. One of the crucial components in information processing is processing speed, and it is also viewed as one of the foundations of cognitive ability in adults (see Deary, 1988; Jensen, 1992). There are changes in information processing speed during the first year of life, and such changes are thought to be related with changes in other aspects of cognitive development, such as verbal ability, reasoning, and spatial ability (see Kail, 1991; Salthouse, 1996). Rose (1980) reported that pre-term 6-month-old infants failed to show novelty preferences in paired-comparison tasks when familiarization time was brief, whereas full-term infants looked longer to novel patterns or faces after the same amount familiarization. In a longitudinal study, Rose, Feldman, and Jankowski (2002) presented infants with a series of paired faces, in which the familiar face remained the same across trials. They found that at all ages, preterm infants needed significantly more time to reach consistent preference to novel faces than full-term infants, suggesting that preterm infants process information less efficiently than full-term infants.

In another study (Rose, Jankowski, & Feldman, 2002), researchers utilized the same technique to examine face processing in 7- and 12-month-old infants. A familiar face was paired with multiple novel faces repeatedly until infants reached criterion of successful recognition, and then they received a probe task in which four novel faces were again paired with the familiar one. For the probe task, in the first condition, they used faces of ¾ profile and full profile poses, preserving the configural integrity of faces. They found that 12-month-olds required 60% fewer trials and half the familiarization time than 7-month-olds to reach consistent novelty preference. Infants who exhibited shorter looks and more frequent shifts demonstrated faster learning in both age groups. For probe trials, both age groups showed novelty preference for the ¾ profile faces, but only older infants recognized novel faces for the full profile trials. In the second condition, the integrity of the faces in the probe trials was disrupted with rotations and fracturing. They found that only 12-month-olds could recognize familiar faces in probe trials with rotated faces. Neither of the groups showed novelty preference in the other condition with fractured faces. However, faster learners at 12 months exhibited signs of recognition of fractured faces. These findings suggest the relation among process speed, processing strategy and efficiency underlying the information process of faces. Faster processing and more frequent shifts were related to more efficient processing.

Furthermore, Kovack-Lesh, Oakes, and McMurray (2012) revealed the possible contributions of attention style and previous experience to infants' categorization. Infants at 4 months were first assessed for attention style based on their switching behaviors and look duration when they were presented with geometric patterns. During the test trials, infants were first familiarized with 12 exemplars of cats, and then a novel cat was paired with a novel dog. The results showed an interaction between attention style and previous experience. Only high-switchers with previous experience with cats demonstrated recognition of cats as a category. In addition, they found that successful learning was related to the switching behaviors during learning itself, but not switching in the pretest with patterns. It seemed that infants did not apply consistent switching strategy across all types of tasks. Attentional style may interact with previous experience, and such interaction may lead to different outcomes of learning behaviors.

These findings bring up the possibility that infants' information processing can be improved with attention manipulations. Modifying infants' visual attention has been explored in some previous studies. Jankowski, Rose, and Feldman (2001) reported that through modifying the distribution of attention, infants' looking strategies could be changed to lead to more efficient information processing. Their experiments involved participants aged 5 months. In previous studies, it was found that infants who tend to look shorter at a stimulus process visual information more efficiently and have better performance than those with longer fixation times (e.g., Colombo & Mitchell, 1990), so infants were determined either to be a short looker or a long looker based on their visual fixation to black-and-white geometric patterns. During the familiarization phase, they sought to modify infants' distribution of attention by highlighting different areas of the stimulus successively using a transparent red light. They found that though long lookers failed to show novelty preference in a control condition, both short and long lookers exhibited novelty preferences after the attention manipulation, and the looking strategy of long lookers was changed to be more similar to short lookers. These findings suggests that, first, it is possible to modify the looking strategy and attention distribution in infants using such highlighting techniques, and second, such modification can facilitate infants' visual information processing and help infants to process visual stimuli more efficiently. One question that remains is if it is possible to eliminate the other-species effect in older infants through changing the looking patterns of infants during familiarization to other-species faces?

The Current study

The current study had two aims. First, I intended to replicate the previous findings that the other-species effect is present at 9 months of age. Second, I aimed to explore the possibility that perceptual narrowing works at the level of selective attention. I asked whether modifying infants' distribution of attention during familiarization can facilitate their processing of other-species faces and eliminate the other-species effect on a single discrimination task in the laboratory environment. Nine-month-old infants were recruited as participants because according to studies reviewed above, perceptual narrowing in face recognition occurs from 6 to 9 months of age. At the age of 9 months, infants fail to discriminate other-species faces (Pascalis, de Haan, & Nelson, 2002; Pascalis et al., 2005; Scott & Monesson, 2009). An attention manipulation, similar to that used by Jankowski, Rose, and Feldman (2001) was used in this study to guide one group of infants' selective attention to the internal features of the face during familiarization with the goal of facilitating their processing of the internal features of the monkey's face. A paired-comparison task was used to test the discrimination of familiar and novel monkey faces.

I made two predictions: 1) 9-month-old control participants would not demonstrate discrimination of other-species faces, and 2) infants in the attention manipulation condition would exhibit discrimination of other-species faces. There are two possible explanations if infants exhibit signs of discrimination after the manipulation procedure. First, it is possible that the attention manipulation modifies the distribution of infants' visual selective attention such that they pay more attention to the internal features of monkey faces. Another explanation is that the attention manipulation elicits infants' focused attention such that they engage in deeper levels of focused attention while viewing the monkey face. To further analyze infants' looking behaviors, peak look duration of infants during the familiarization phase was analyzed as an index of focused attention. Look duration is an important measure of infants' visual attention (for a review see Ruff and Rothbart, 2001). Therefore, if the successful discrimination in the paired-comparison task is due to deeper levels of focused attention induced by attention manipulation, the experimental group should exhibit longer peak look duration during familiarization phase. If the attention manipulation modifies the selective attention of infants to the internal features of the monkey faces, infants in the control group and the experimental group should engage in focused attention at the same level. Therefore, the two groups should exhibit no significant difference in peak look duration.

Chapter 3

Materials and Methods

Participants

A sample of 29 infants (14 males, 15 females; 27 Caucasian, 1 Hispanic, 1 Hispanic-African) was tested at 9 months of age. All infants were recruited within a week of their 38 week birthdates. Only infants born full term (at least 38 weeks gestation) without complications and of normal birth weight were included in the sample. Four additional infants were tested but excluded from the final data because of fussiness (n=2) and technical problems (n=2).

Apparatus and stimuli

Participants were held on their parent's lap in a quiet room, and were seated 55 cm from the center of a 27 in. color LCD monitor. A digital camcorder (Sony DCR-HC28; New York, NY) was located above the monitor in order to videotape infants' looking behavior. Fixation was judged online through a video feed to a computer in the control room. The procedure was controlled by E-Prime 2.0 software. The experimenter held a key when the infant was looking at the stimulus, and the accumulated time was computed by the program. Eighteen digitized color photographs of Barbary macaques (*Macaca sylvanus*) (Pascalis et al. 2005; Scott and Monesson, 2009; Scott and Johnson, 2010) presented against a white background were used as stimuli. See Figure 1 for examples. Black curtains were used to cover the surrounding areas to block irrelevant stimuli of the room. The lighting of the experiment room was off during testing.

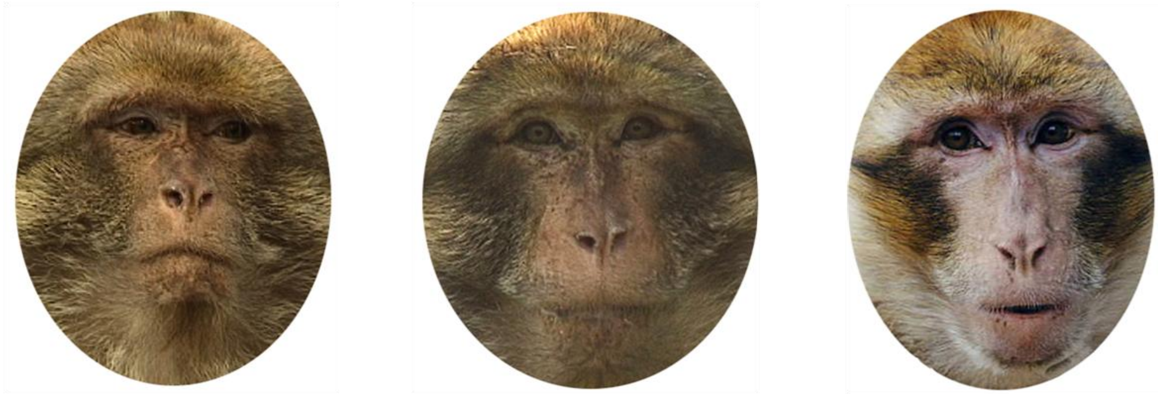

Figure 1. Examples of Barbary macaques (Macaca sylvanus) faces used as stimuli.

Procedure

Experimental condition. After the informed consent process, infants sat on a parent's lap in front of the computer monitor. The experiment consisted of two phases, a familiarization phase and a paired-comparison phase (discrimination test). In the familiarization phase, the infant was presented with one of the monkey faces measuring 20 cm×17 cm at a visual angle of 16.2°. The face was presented in the center of the monitor. A yellow transparent rectangle was used to highlight different internal features to guide infants' attention to different areas of the face. The sequence of highlighting was eyes, nose, and mouth, followed by the face without any highlightings (see Figure 2). The highlighted area was changed every 2.5s. This pattern was repeated until infants reached 20s of accumulated looking time to the stimulus.

The second phase was a paired-comparison task to test for discrimination. At first, a cartoon image appeared in the center of the screen. After infants fixated to the central point, the familiar face from the first phase was presented paired with a novel monkey face. The two photographs, measuring 20 cm × 17 cm at a visual angle of 16.2°, were separated by a 20 cm gap and appeared on the left and right sides of the screen equidistant from the central fixation point. After the infant reached 5s of accumulated looking time to the stimuli, the positions of the two photographs were reversed for another 5s of accumulating looking. Therefore, for this phase, a total of 10s accumulated looking time was attained. The position of the familiar stimulus for the first paired-comparison trial was counterbalanced across participants.

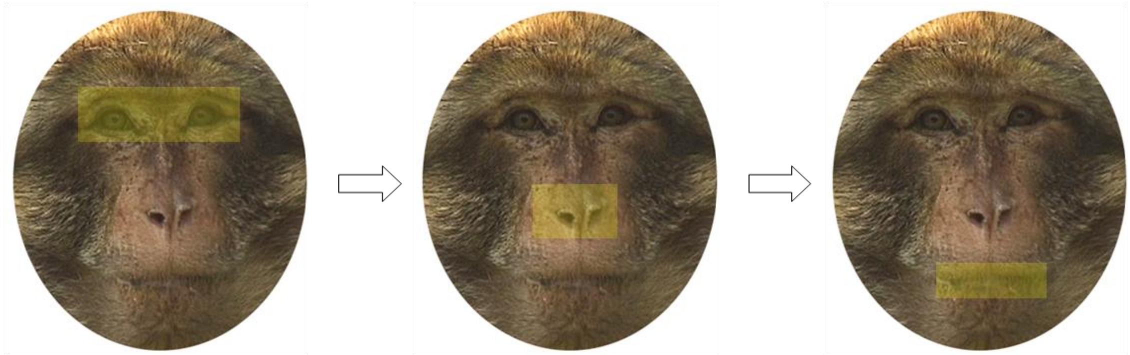

Figure 2. *Faces with highlight in familiarization phase. A yellow transparent rectangle was used to highlight different internal features to guide infants' attention focusing on different parts of the face. The highlighted area was changed every 2.5 s. This pattern was repeated until infants reached 20 s of accumulated looking time to the stimulus.*

Control condition. The control condition had a similar procedure to the experimental condition, except there was no attention manipulation during the familiarization phase. During the familiarization phase, the monkey face was presented without any colored highlighting. A 20s accumulated looking time was required. The paired-comparison procedure was the same as that in the experimental condition. A 10s accumulated looking time was required.

Analysis of looking behaviors

The looking behaviors of participants were judged offline frame by frame by a trained observer to determine each participant's looking to the familiar face during familiarization and to the two faces during the visual paired-comparison phase. For the looking behaviors during familiarization phase, I analyzed three variables: average look duration, peak look duration, and number of looks. Average look duration was defined as the mean duration of each look during the 20 s of accumulated looking to the monkey face. Peak look duration was defined as the length of the longest look during the 20 s of accumulated looking to the monkey face. Number of looks was defined as the number of separate looks used by infants to reach the 20 s of accumulated looking. For 20% of the participants, looking behaviors were judged by a second observer. Both observers were blind to the stimuli presented to the participants. Pearson's correlation coefficient and Cohen's Kappa revealed significant reliability between observers (*R*=.99, *Kappa*=.91).

Chapter 4

Results and Discussion

Results

Descriptive data on the looking time measures are shown in Table 1 and Table 2. The peak and mean look duration and the number of looks to reach criterion from the familiarization phase were analyzed using two-tailed independent sample *t* test. It was found that there were no significant differences between the control group and the experimental group in average look duration, $t(27)=.197$, $p=.847$, peak look duration, $t(27)=.423$, $p=.676$, or number of looks, $t(27)=1.04$, $p=.307$.

For the paired-comparison phase, the data were analyzed using two-tailed *t* tests comparing the percentage of time fixating the novel stimulus out of the total fixation time with a chance level (50%). The findings indicate that in the experimental group, infants

Table 1 Average look duration (s), peak look duration (s), and number of looks of the control and the experimental group.

	Average Look		*Peak Look*		*Number of Looks*	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	5.92	7.82	8.91	7.40	5.57	2.10
Experimental	5.39	4.73	9.93	5.51	6.80	3.91

Table 2. Length of looking (s) and looking proportion based on total looking to familiar and novel stimuli during the paired-comparison task.

	Total		*Familiar*		*% to Familiar*		*Novel*		*% to Novel*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Control	12.19	1.15	5.99	1.26	49.5%	10.4%	6.20	1.67	50.5%	10.4%
Experimental	12.61	1.59	5.17	2.16	40.6%	13.3%	7.43	1.75	59.4%	13.3%

showed novelty preferences in the paired-comparison task, with significantly more time looking to the novel face (*M*=59.4%, *SD*=13.3%), $t(14)=2.744$, $p=.016$. However, infants in the control group showed null preferences in the paired-comparison task, *M*=50.5%, *SD*=10.4%, $t(13)=.197$, $p=.847$, as can be seen in Figure 3**.**

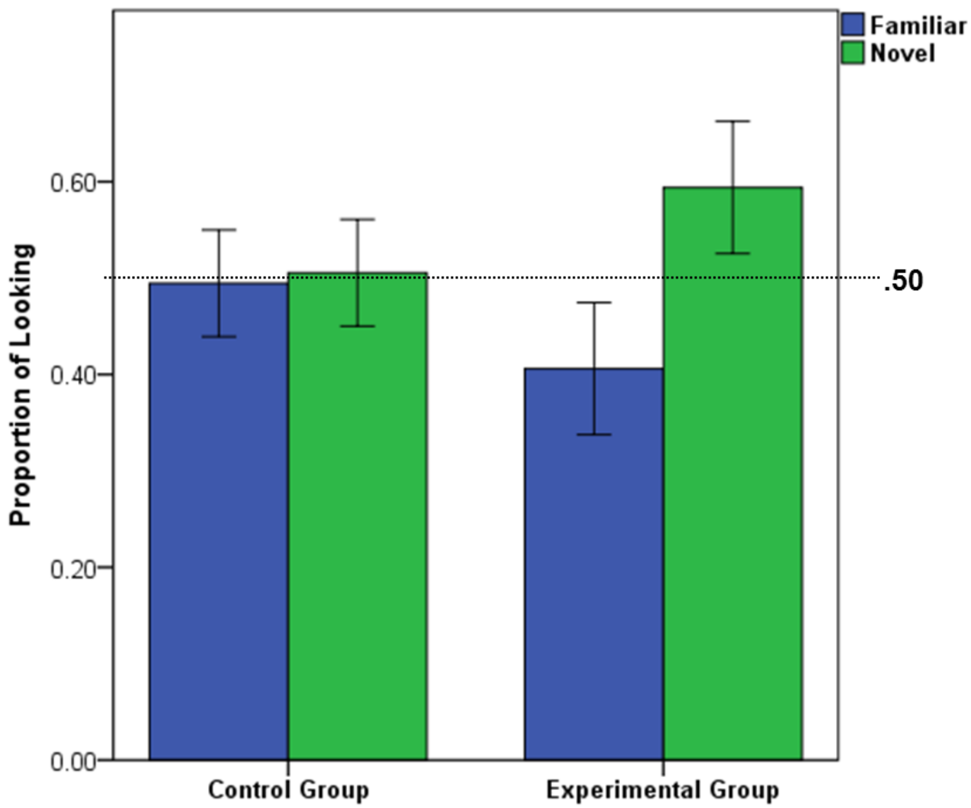

Figure 3. *Looking proportion to familiar and novel stimuli in each group. Infants in the control group showed null preferences in the paired-comparison task, whereas infants in the experimental group demonstrated significant preferences looking at the novel faces*

Discussion

As predicted, the control group did not show evidence of discrimination of monkey faces. In contrast, it was found that after familiarization with an attention manipulation designed to modify the distribution of infants' selective attention, infants in the experimental group exhibited novelty preferences in paired-comparison task which is indicative of discrimination of the different monkey faces. Therefore, highlighting the internal features of monkey faces appears to facilitate infants' processing of non-native faces. The findings from the control group replicate the findings of Pascalis and colleagues (Pascalis, de Haan, & Nelson, 2002; Scott, Shannon, & Nelson, 2006; Scott & Monesson, 2009, 2010). The findings also provide further evidence of plasticity of face processing in early life, but different from previous studies in which infants were exposed to monkey faces for a prolonged period (e.g., Scott & Monesson, 2009, 2010), this was an immediate effect that occurred through manipulating the infants' attention distribution during familiarization. According to Jankowski, Rose, and Feldman (2001), highlighting different parts of the stimuli can effectively modify infants' looking patterns, and such manipulation can improve infants' performance on discrimination tasks. However, these findings extend this method from geometric patterns to faces from nonhuman species.

Scott and Monesson (2009) suggest that older infants treat other-species faces differently from the faces they experience in everyday life. According to Cohen and Cashon (2001), by 7 months of age, infants have learned to process faces as a configuration, not a collection of independent features, leading to an inverse effect which is specific to face processing. Inverting human faces interrupts 7-month-old infants' information processing, and leads to failure to discriminate familiar and novel faces. However, Scott and Monesson (2010) reported that an ERP inversion effect can only be observed in 9-month-old infants with previous exposure to monkey faces at an individual level but not at the category level, suggesting that infants may not engage in typical processing with other-species faces exactly the same as they do in human face processing. It is possible that since infants at this age typically process monkey faces at the categorical level, they do not engage in detailed processing of faces from other species. Specifically, as their exposure to human faces increases, they recognize monkey faces only at the categorical level, but treat human faces at the individual level. Similar suggestions involving the other-race effect have been proposed by Anzure and colleagues (2010) in that 9-month-old infants start to engage in categorization of own-race faces and categorical perception of other-race faces. As a result, 9-month-olds infants process faces from their own-race at the individual level, and fail to tell the difference between other-race faces. However, with individuation training, infants can maintain their ability to discriminate faces from other species, showing plasticity of face processing in infancy (Pascalis et al., 2005; Scott & Monesson, 2009). In the present study, the attention manipulation method worked successfully and facilitated the experimental groups' face processing. Modifying infants' attention to monkey faces improved their performance in discrimination tasks of monkey faces. With the highlighting, infants may have engaged in more efficient processing of the other-species faces, which helped them to recognize that particular monkey face at the individual level.

However, why highlighting the internal features facilitated the processing of the face from an other-species is not clear. One explanation is that highlighting monkey faces draws infants' attention to the faces *per se*, leading to deeper level of focused attention to face as opposed to specifically focusing on the internal features that were highlighted. To further analyze the possible mechanism behind the current findings, I examined the look duration during familiarization phase to explore how attention manipulation possibly changed the looking patterns of 9-month-old infants. It was found that there was no significant difference between the control group and the experimental group in the average look duration, the peak look duration, or the number of looks during the familiarization phase, suggesting that the highlighting used in the familiarization phase may not increase the level of focused attention in infants. Infants with the attention manipulation may engage in focused attention to the monkey faces at the same level as infants in the control group.

Since the attention manipulation does not appear to lead to deeper levels of focused attention in the familiarization phase, it is likely that the attention manipulation procedure guides their selective attention to internal features of the monkey face, which facilitates infants' ability to discriminate that specific monkey face from other monkey. Previous studies have demonstrated that experience plays a key role in perceptual narrowing (Kelly et al., 2007; Scott & Monesson, 2009; Pascalis et al., 2005), but how infants process faces from nonnative categories and whether they use different strategies is still not clear. Liu and colleagues (2010) reported that the time infants spent looking at the internal features of other-race faces decreased with increasing age, whereas the time they spent looking at the internal features of own-race faces was maintained, demonstrating differences in the distribution of selective attention to faces from unfamiliar categories. Thus, with increased experience with own-face faces, infants develop unique strategies in information processing. Such strategies may be more efficient to discriminate faces at the individual level. The current findings indicate that after the occurrence of perceptual narrowing, modifying infants' selective attention to other-species faces helps them to process the specific stimulus more efficiently, suggesting that selective attention plays an important role in the other-species effect, and perceptual narrowing may work at the level of selective attention. Further studies are needed to explore the exact function of attention in the perceptual narrowing process observed in face recognition.

Chapter 5

Conclusions and Recommendations

One limitation of the present study was that infant looking was only measured to the face and not the different areas of the face. It is not clear whether highlighting the internal features made the infants follow the highlighting to different parts of the faces, or focus more on the whole face. Though the findings suggest that the attention manipulation did not change the level of focused attention, it was an indirect measure of visual attention. Adding another condition in which the whole face is highlighted would be helpful. However, eye-tracking would also be an ideal technique to examine how infants scan faces of other species with and without an attention manipulation. In addition, the current study can only provide behavioral evidence to support the effect of attention manipulation on other-species effect. Future studies may utilize psychophysiological methods (i.e. ERPs, heart rate) to further explore this area.

The current study focused on infants' processing of a single face, and indicated that the attention manipulation procedure worked to facilitate infants' recognition of one particular monkey face at one time. Future research should focus on how selective attention and experience interact in the perceptual narrowing process during the first year of life. Other aspects of perceptual narrowing should also be explored, in particular in language perception. Previous studies suggest that social interaction is important to eliminate the decline in ability to discriminate speech contrasts present in foreign languages. For example, Kuhl, Tsao, and Liu (2003) found that only 9-month-old infants who were engaged by foreign speakers in a play session could discriminate non-native speech contrasts, but infants who were exposed to audiovisual or audio-only recordings failed to discriminate the contrasts. In the field of face perception, it was found that attention style and previous experience interacted to improve the recognition of cat faces in 4-month-old infants (Kovack-Lesh, Oakes, and McMurray, 2012). In the present study, a simple attention manipulation worked to eliminate the other-species effect in a single discrimination task in the laboratory. It is unlikely that this manipulation would have any prolonged effects on infants' ability to recognize non-native faces. Thus, experience may work to direct the distribution of infants' selective attention differentially based on how relevant that type of information is in their everyday lives. How experience interacts with selective attention, still needs further investigation.

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Vita

Dantong Zhang was born in Jinan, China on March 3rd, 1987. She became interested in psychology when she was a little girl. When she graduated from high school, she decided to choose psychology as her major at Shandong Normal University in China. The courses in psychology fascinated her, and she had a good time at school. After two years in SDNU, she discovered an exchange program held by SDNU and East Tennessee State University in which students could study at ETSU for two years. She considered it a good opportunity to experience and learn another culture. She finally succeeded to pass the language test and was admitted by ETSU.

It was the beginning of Dantong Zhang's five years in the United States when she first came to this country in 2007. Everything was interesting at ETSU and she did a good job on her coursework. She worked as a lab assistant in Dr. Wallace E. Dixon from Jan. 2008 to May 2009. She graduated as a Summa Cum Laude from ETSU in 2009.

From August 2009, Dantong Zhang worked as a graduate student with Dr. Greg D. Reynolds. Her research was on infant cognition and memory. She participated in several international conferences, and had a few publications during three years. Her thesis was on other-species effect during the first year of life, titled "The Role of Attention in Other-Species Effect in Infancy". She successfully passed her thesis defense, and got her M. A. in August 2012.